Citation:

van Dam RM, Willett WC, Rimm EB, Stampfer MJ, Hu FB. Dietary fat and meat intake in relation to risk of type 2 diabetes in men. *Diabetes Care*. 2002 Mar; 25 (3): 417-424.

PubMed ID: 11874924

Study Design:

Prospective cohort

Class:

B - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To examine the association between risk of type 2 diabetes (T2D) and trans-fat, specific polyunsaturated fats and meats.

Inclusion Criteria:

Participants of the Health Professionals Follow-up Study, which started in 1986 when male health professionals aged 40-75 years responded to a detailed mailed questionnaire.

Exclusion Criteria:

- Males who did not report a daily energy intake between 3.3 and 17.6MJ (800 and 4,200kcal) or had blank responses for >70 of 131 food items on the diet questionnaire
- Men who reported diabetes, cardiovascular disease (myocardial infarction, angina pectoris, coronary artery surgery or stroke) or cancer (except non-melanoma skin cancer) at baseline.

Description of Study Protocol:

Recruitment

The Health Professional's Follow-up Study began in 1986 when 51,529 male health professionals completed a mailed questionnaire on medical history, diet and other potential risk factors for major diseases.

Design

Prospective cohort study.

Dietary Intake/Dietary Assessment Methodology

Diet was assessed with a 131-item semiquantitative food-frequency questionnaire (FFQ) to determine how often, on average, each food was consumed in the amount specified during the past year.

Blinding Used

Not applicable.

Intervention

Not applicable.

Statistical Analysis

- Follow-up for each subject time started from the return of the 1986 questionnaire until diagnosis of T2D, death, or the end of the study period
- Relative risks were calculated by dividing the incidence rate of T2D among men in each category of intake by the rate in the lowest category
- Pooled logistic regression with two-year intervals was used to estimate multivariate-adjusted relative risks for each category of intake as compared with the lowest intake
- To better represent long-term intake, the cumulative average of dietary intakes from all available dietary questionnaires up to the start of each two-year follow-up interval
- Linear trends across categories of dietary intake were tested by assigning each participant the median value for the category and modeling this value as a continuous variable. Dietary intake and potential confounders were also modeled as continuous variables.

Data Collection Summary:

Timing of Measurements

- Diet was assessed by questionnaire in 1986 (baseline), 1990 and 1994
- Diabetes and other variables were assessed by questionnaire every two years from baseline in 1986 through 1998.

Dependent Variables

- Type 2 diabetes: A supplementary questionnaire on symptoms, diagnostic tests and medication was mailed to all men who reported a diagnosis of diabetes on a follow-up questionnaire
- Confirmation of diabetes was based on criteria consistent with those proposed by the World Health Organization (WHO) in 1985.

Independent Variables

Diet was assessed by a semi-quantitative FFQ and daily nutrient intakes were calculated.

- Meat consumption daily (unprocessed, processed, specific meats)
- Fat consumption daily (saturated fat, oleic acid, trans-fat, linoleic acid, alpha-linolenic acid, long-chain n-3 fat, cholesterol, polyunsaturated fat).

Control Variables

- Age

- Total energy intake
- Time period
- Physical activity
- Cigarette smoking
- Alcohol consumption
- Hypercholesterolemia
- Hypertension (HTN)
- Family history of type 2 diabetes
- Intake of cereal fiber and magnesium
- Body mass index (BMI)

Description of Actual Data Sample:

- *Initial N:* 51,529
- Att*rition (final N):* 42,504 (after exclusions)
- *Age:* 40 to 75 years at baseline
- *Ethnicity:* Predominantly white
- *Other relevant demographics:* Health professionals
- *Anthropometrics:* None
- *Location:* US.

Summary of Results:

Key Findings

- During 12 years of follow-up, 1,321 incident cases of T2D were identified. Frequent consumption of processed meat was associated with a higher risk for T2D (RR=1.46; 95% CI: 1.14, 1.86 for at least five per week vs. less than one per month; P for trend<0.0001). Consumption of unprocessed red meat (RR=1.05; 95% CI: 0.85, 1.30 for highest vs. lowest quintile) and of poultry (RR=1.12; 95% CI: 0.95, 1.32) was not substantially associated with risk for T2D. Of the eight questionnaire items on meat and poultry consumption, only consumption of the three processed meat items: bacon (RR=1.33; 95% CI: 1.11, 1.58; P for trend=0.0002), hot dogs (RR=1.26; 95% CI: 1.00, 1.60; P for trend=0.03) and other processed meats (RR=1.18; 95% CI: 0.99, 1.41; P for trend=0.01) plus hamburgers (RR=1.27; 95% CI: 0.99, 1.62) were appreciably associated with diabetes risk. Consumption of beef, lamb or pork as a main dish or a mixed dish; or chicken or turkey with or without skin was not substantially associated with risk of T2D
- In unstratified analyses after adjustment for all potential confounders considered in multivariate analysis, there was no association between T2D and intake of specific fats
- In multivariate analyses stratified by age and BMI, greater intake of linoleic acid was significantly associated with a lower risk of diabetes among men younger than 65 years (RR=0.74, 95% CI: 0.60-0.92 for highest vs. lowest quintile, P for trend=0.01) and among men (0.53, 0.33-0.85, P for trend=0.006). No other significant associations were observed within strata of age, BMI, or physical activity.

Author Conclusion:

- Intake of total and saturated fat was associated with a higher risk of T2D, but only prior to adjustment for BMI
- Intake of linoleic acid was inversely associated with risk of T2D in men <65 years of age and men with a BMI <25kg/m^2, but not in older and obese patients
- Frequent consumption of processed meat was associated with an increased risk of T2D.

Reviewer Comments:

Study Strengths

- *Large number of participants, long follow-up period, high rate of follow-up*
- *Extensive information in potential confounders*
- *Self-reported diabetes confirmed by supplementary questionnaire (accurate when validated with medical records)*
- *Diet and some potential confounders were through the follow-up period to account for changes in the variables*
- *The validity of the diet questionnaire was assessed.*

Study Limitations

- *Diabetes diagnosis not ascertained with measurement of blood glucose*
- *Measurement error in self-reported dietary assessment.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions		
1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	N/A
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	N/A

Validity Questions		
1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes

1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	???
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A

5.	**Was blinding used to prevent introduction of bias?**	No
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	N/A
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	No
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	N/A
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes

7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	N/A
8.7.	If negative findings, was a power calculation reported to address type 2 error?	No
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes